LESSON TITLE: AND SEAL FAILURE
PROGRAM: 326\506
REV 0

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1.0 TRAINING AIDS

1.1 LESSON PACKAGE #13

1.2 TRANSPARENCY PACKAGE #13

2.0 REFERENCES

2.1 B&W ADVANCED COURSE MANUAL -CHAPTER 5

A-16

3.0 LEARNING OBJECTIVES

3.1 COVER LEARNING OBJECTIVES ON PAGE 5-1

4.0 PRESENTATION
THIS PRESENTATION COVERS THE SEQUENCE OF EVENTS OF THE AND DURING THE SEAL FAILURE EVENT.

4.1 t=0145 - the Reactor Operator discovers that a seal failure is in progress.
4.1.1 A leak rate calculation is in progress, and he observes a step decrease in Makeup Tank Level
4.1.2 RCP seal pressures and seal return flow changes confirms leakage.
4.1.2.1 Cover seal pressure changes
4.1.2.2 Seal return flow increases are caused by an increase in the differential pressure.

4.2 Seal Leakage Limits are in excess of Technical Specifications and an orderly shutdown is ordered by the Shift Supervisor.
4.2.1 Initial Rate of power reduction is 5% per minute
4.2.2 177 FA ICS is designed to manuver at 10% per minute
4.2.3 The initial seal leak rate was 10 to 20 GPM

4.3 t=0214 (+19 min) - Unit electrical loads are transferred from the unit auxiliary transformer to the startup transformer in preparation for plant shutdown.

4.4 t=0220 (+25 min) - RCS Letdown is isolated to minimize the loss of pressurizer level

4.5 t=0227 (+37 min) - During the load decrease, the rate of seal leakage increased, and the operators increase the rate of load decrease to 20 to 30% per minute.
4.5.1 Student Question - How can the rate of load decrease be increased above 10% per minute?

4.5.2 Answer - In track, the rate of load change is 20 percent per minute.

4.6 t=0247 (+62 minutes) - Generator off line.

4.7 t=0248 (+63 minutes) - "C" RCP is stopped.
4.7.1 Pump is stopped after the unit is off line to prevent the rationing of feedwater and the upset condition that this transient causes.
4.7.2 t=0250 (+65 min) - manual reactor trip in response to increased
4.7.3 Four actions are taken ~~to minimize~~ seal leakage that is in the range of 250 to 300, GPM

4.7.3.1 HPI is manually initiated by:
4.7.3.1.1 Starting a second Makeup pump
4.7.3.1.2 Opening the suction valves from the BWST
4.7.3.1.3 Opening the HPI motor operated valves
4.7.3.2 RCP Lift pumps are started and stopped in an effort to change the seal package location
4.7.3.3 The Seal Return Isolation valve is closed.
4.7.3.4 Seal injection is increased to quench the steam and water mixture from the pump

4.8 t=0256 (+71 min) - RB coolers are placed in service
4.8.1 Reactor building pressure is increasing because of steam leakage from the seal.
4.8.2 Prevents high building pressure ESF

4.9 t=0301 (+76 min) - Stopped "A" RCP in preparation for a cooldown of the RCS.

4.10 t=0305 (+80 min) - A cooldown rate of 75 degrees per hour is established
4.10.1 "C" makeup pump is stopped, and all HPI MOVs are closed. Normal Makeup with the exception of the suction source which is the BWST.
4.10.2 Due to the High cooldown rate, the operator did not bypass SLBIC system soon enough to prevent actuation.
4.10.2.1 Steam driven EFW starts
4.10.2.2 Raised header pressure to >600
4.10.2.3 Bypassed SLBIC
4.10.2.4 SLBIC auto resets when pressure is >650.
4.10.2.5 "A" OTSG pressure actuates SLBIC
4.10.2.6 Header pressure raised above 600 psig
4.10.2.7 SLBIC sucessfully bypassed

4.11 Steam driven EFW pump stopped. Auxiliary Feedwater placed in service

4.12 t=0800 (+375 min) - Containment entry to power up and close CFT outlet valves
4.12.1 Valves were powered from switchboard on the 375' elevation of containment. One floor above ground level.
4.12.2 The CFTs inject some water prior to isolation.

4.13 t=0900 (+435 min) - Unit in cold shutdown.

4.14 Failure Analysis
4.14.1 All three seals had failed
4.14.2 The upper seal had the most damage
4.14.3 The stationary carbon seal had disintegrated. It is believed that this was the initial failure. The other two seals failed due to upward movement.
4.14.4 Upper seal failed due to excessive wear or fatigue

4.15 Plant Fixes

4.15.1 All four RCP seal packages replaced
4.15.2 CFT breakers are relocated outside of containment
4.15.3 60,000 gallons of radioactive water that had collected in the RB was totally reprocessed without any release to the environment.

5.0 Oconee Unit 2 Seal Failure.

5.1 Initial problem
5.1.1 A leak is discovered on the seal supply line to one of the four reactor coolant pumps
5.1.2 Three and a half hours later, seal inject is isolated to the affected pump to facilitate repairs.
5.1.3 Leakage continued
5.1.4 All seal injection is isolated by closing the total seal flow control valve for the repair, but again, leakage continued.

5.2 After 9 hours, a manual isolation valve is closed to stop seal injection leakage.
5.2.1 Plant Computer Alarms during next 16 minutes
5.2.1.1 High seal inlet temperature
5.2.1.2 Quench Tank Pressure High
5.2.1.3 RCP seal leakoff flow High
5.2.1.4 Affected RCP Off
5.2.1.5 Affected RCP seal return isolated
5.2.1.6 Unaffected RCP seal inlet temp high
5.2.1.7 RCP Motor temperature alarms
5.2.1.8 High Quench tank level
5.2.1.9 Reactor Trip
5.2.2 3 Minutes after the seal was manually isolated, the following operator actions were performed.
5.2.2.1 Manual load reduction to 22%
5.2.2.2 Turbine removed from service
5.2.2.3 Manual reactor trip from 15%
5.2.2.4 RCS cooldown commenced

5.3 Fourteen minutes following the reactor trip
5.3.1 RB entry to investigate fire alarms and oil catch tank alarms
5.3.2 Steam blowing from failed seal is causing alarms .

5.4 Cooldown events fourteen hours after the seal leak was discovered
5.4.1 The core flood tanks are vented to the Quench Tank
5.4.1.1 Normally vented to vent header
5.4.1.2 Can shut CFT isolation valve and avoid venting
5.4.2 Quench Tank is overpressurized
5.4.3 Rupture disk blows
5.4.3.1 Pressurizer level sensing line is severed
5.4.3.2 Insulation on the bottom of the pressurizer is damaged

5.5 Summary
5.5.1 Seal leakage estimated to be 90 GPM

5.5.2 50000 gallons total is collected
5.5.3 12 inches deep in RB